



Predictability of High Impact Weather during the Cool Season over the Eastern U.S: From Model Assessment to the Role of the Forecaster

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CSTAR Partners:

HPC – David Novak et al.

EMC – Yucheng Song, Jun Du, and Jordan Alpert

OPC – Joseph Sienkiewicz et al.

WFO-OKX: Jeff Tongue et al.

WFO-PHI: Al Cope et al.

WFO-CTP: Richard Grumm et al.

WFO-PIT: Josh Korotky et al.

Others Welcome to Join....

Motivation

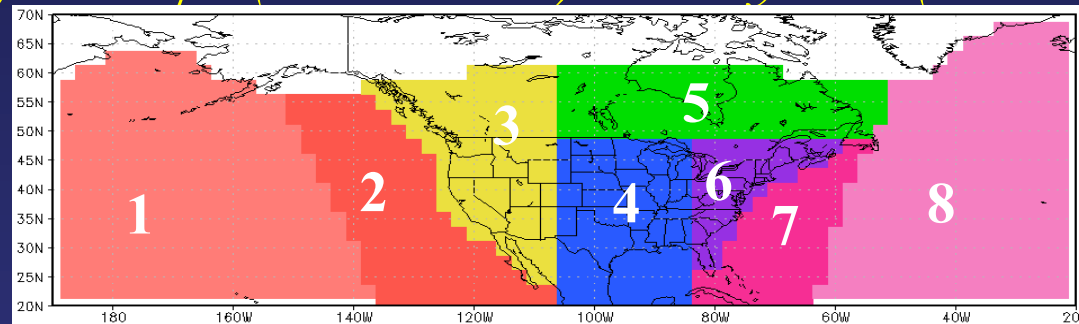
Forecasters have increasing ensemble guidance available,
but ensemble data is often not used effectively since:

- * *ensembles have not been comprehensively verified, especially for high impact events.*
- * *ensemble underdispersion and biases limit ensemble skill.*
- * *forecasters lack tools to understand the origin of ensemble spread and errors in realtime.*
- * *forecasters have few ways to communicate uncertainty in their forecast products.*

CSTAR Goals

- * Quantify extratropical cyclone and associated Rossby wave packet errors within operational ensembles (TIGGE) and their upstream sources.*
- * Relate wave packets to the downstream impact of targeted observations on Eastern U.S. medium range forecasts, and educate forecasters on this process.*
- * Precipitation band predictability within the comma head of extratropical cyclones and ensemble sensitivity analysis.*
- * Operational ensemble verification, post-processing, and operational applications for the forecaster.*

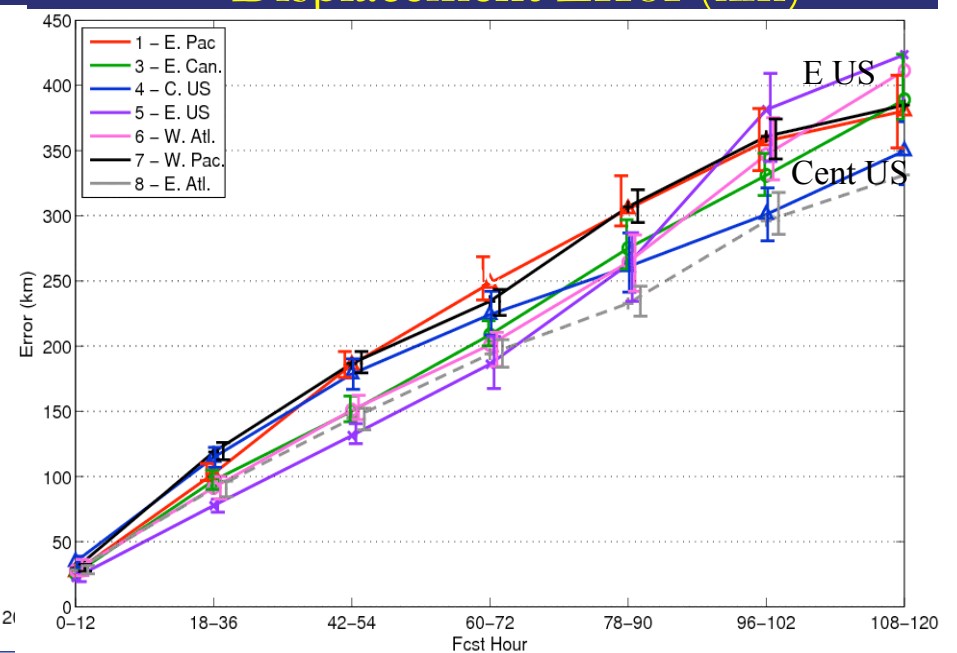
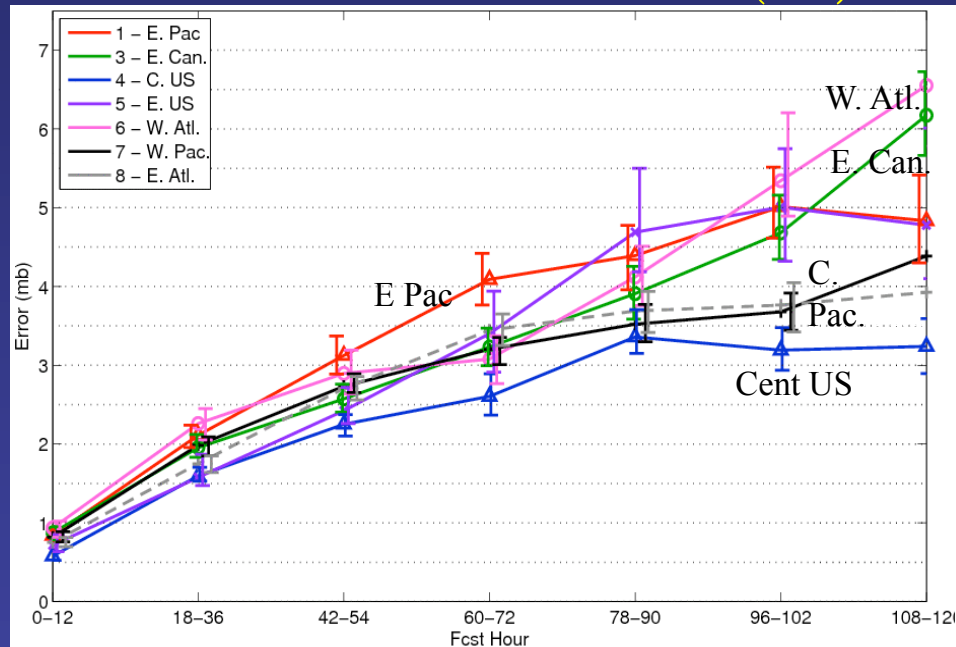
SLP Errors for "Deep" (> 1.5 stn dev) GFS Cyclones (2002-2007 cool season)



Colle and Charles 2010 (submitted to WAF)

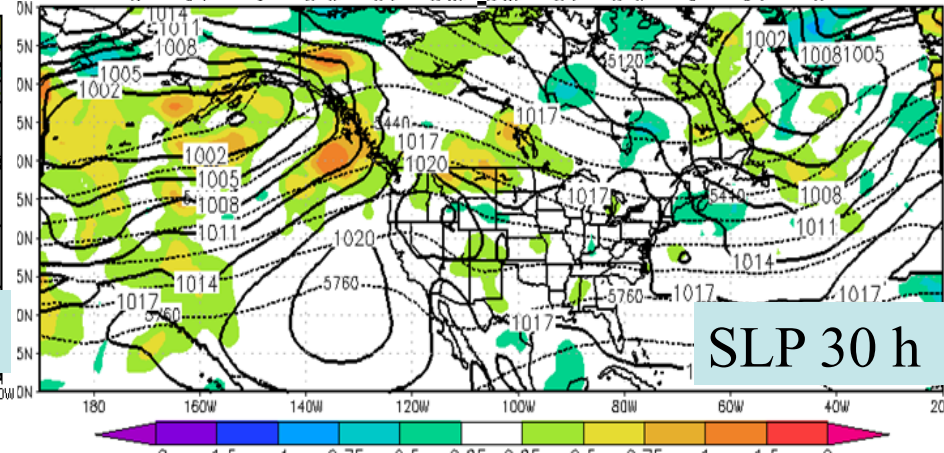
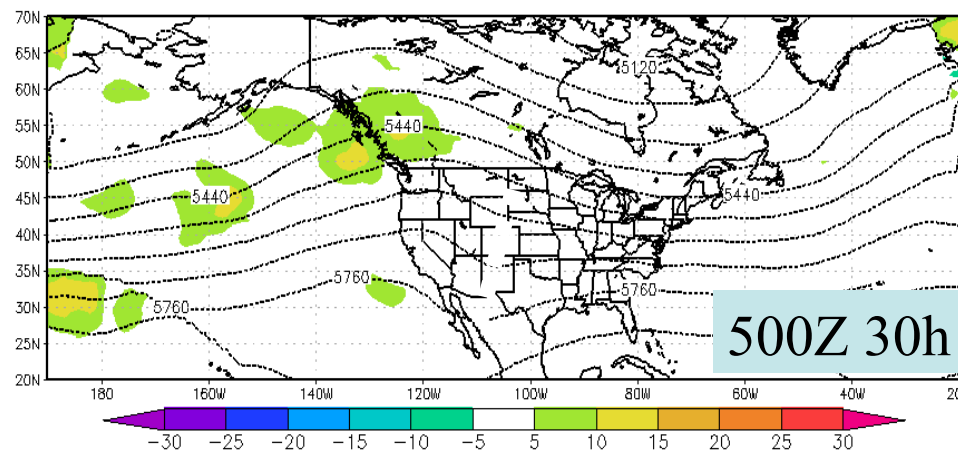
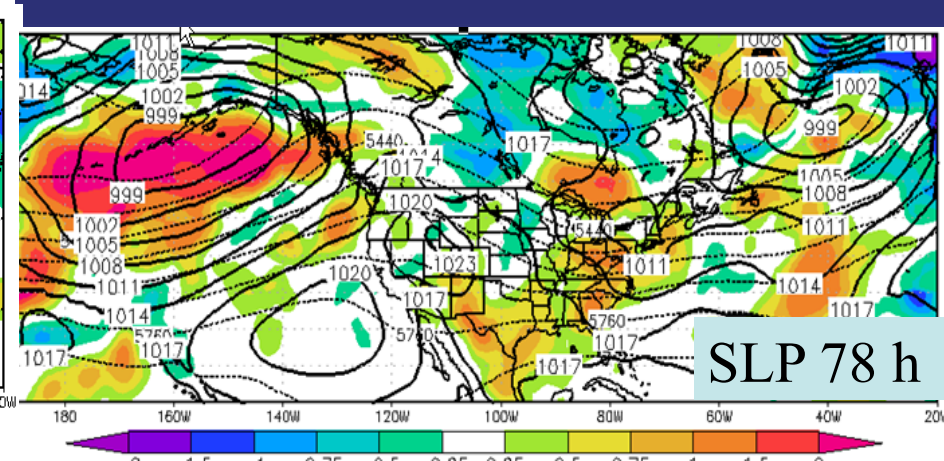
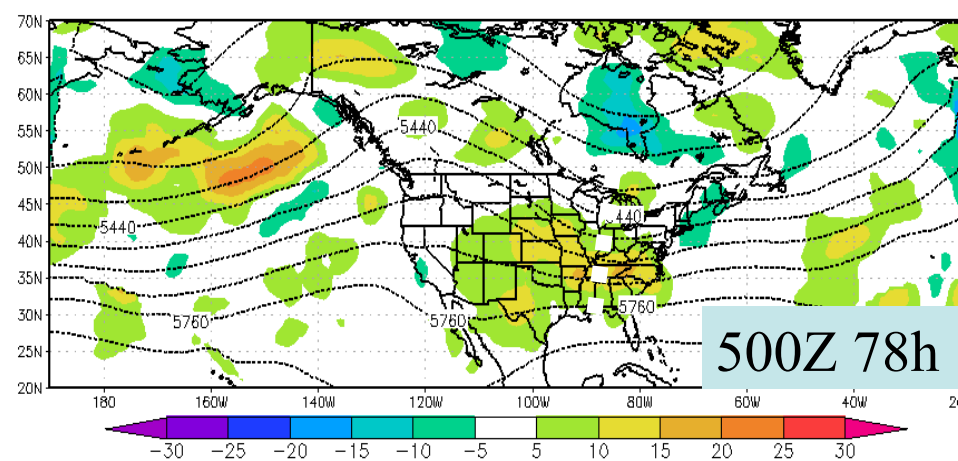
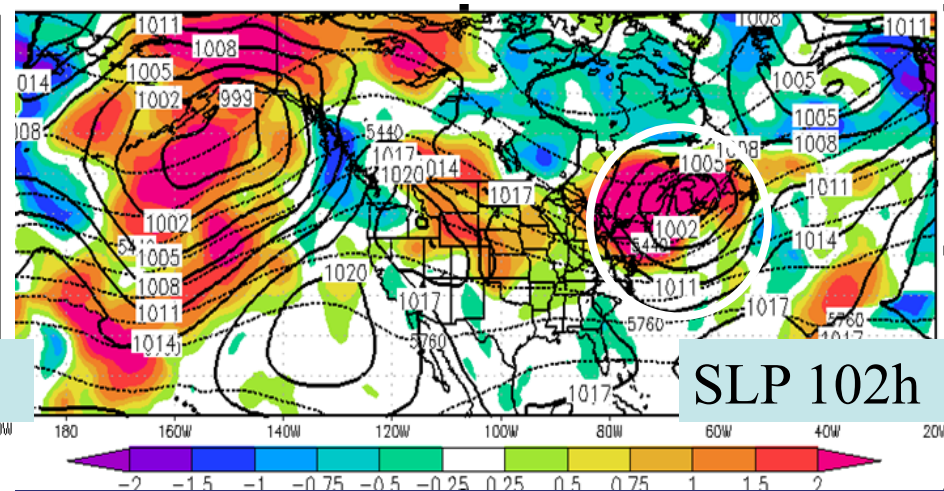
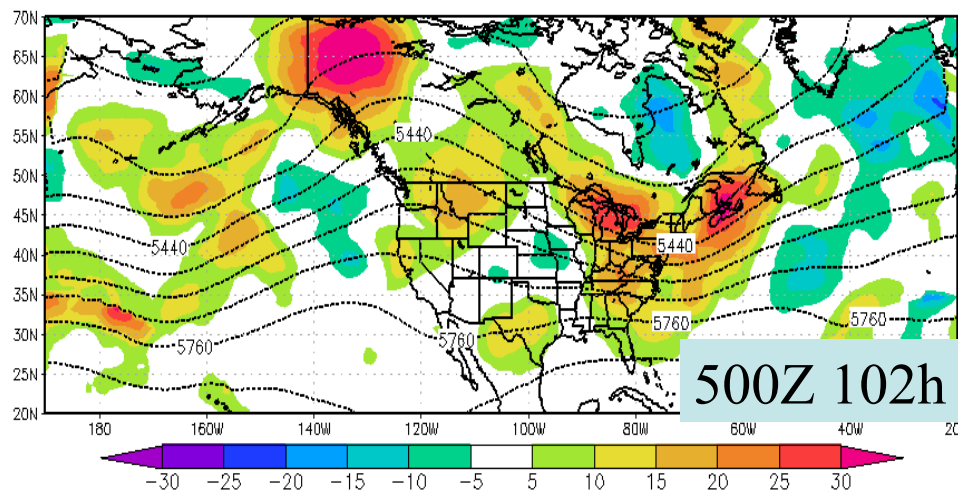
Central Pressure Abs Error (mb)

Displacement Error (km)



Threshold for Deep Cyclones (mb)

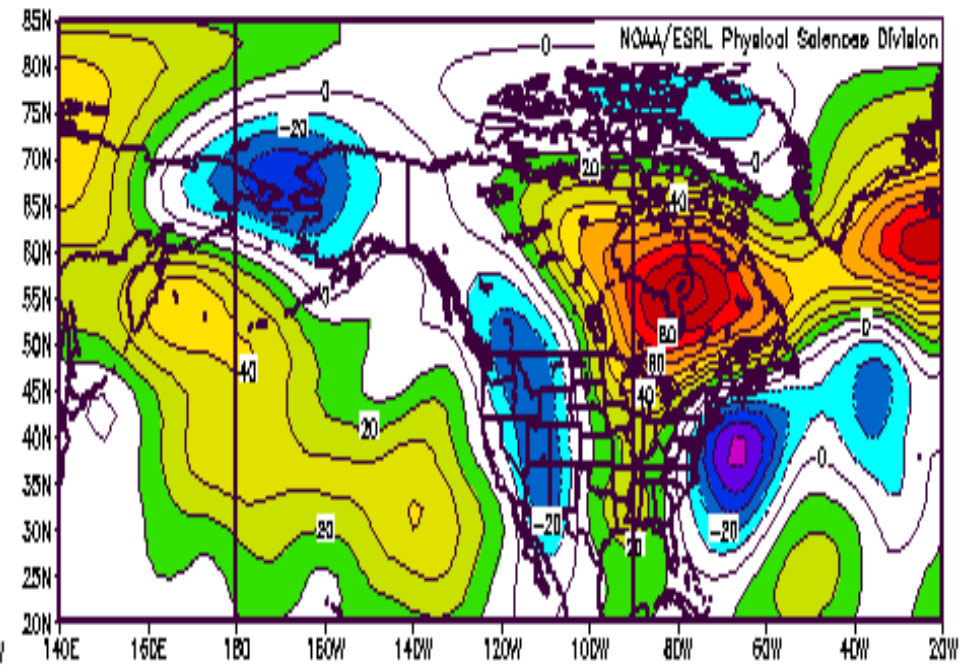
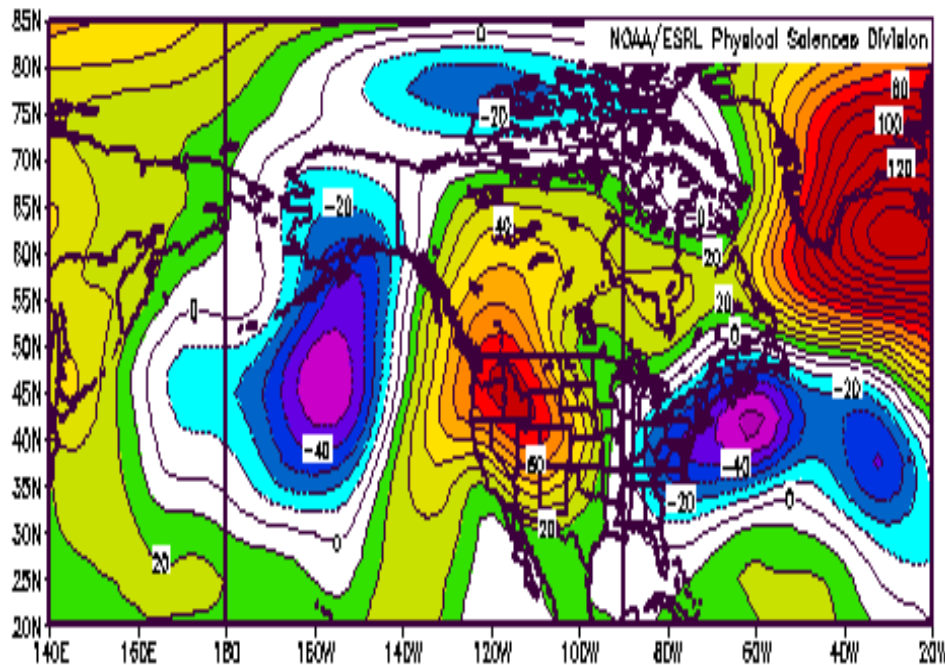
Region	1	2	3	4	5	6	7	8
SLP	964	969	988	994	976	982	983	965



*Daily NCEP/NCAR Composite of 500 mb Z Anomaly
from Climo For F96 Cyclone SLP Mean Errors (> 1.5
stndev)
along the U.S. East Coast*

Positive Cyclone SLP Error (28 cases)
GFS Underdeepened Events F96

Negative Cyclone SLP Error (35 cases)
GFS Overdeepened Events F96



Ensemble Sensi and Wave Packets

UMiami/NCEP-SAP based on NCEP/ECMWF/CMC-Initialised ETKF summary map and Z500

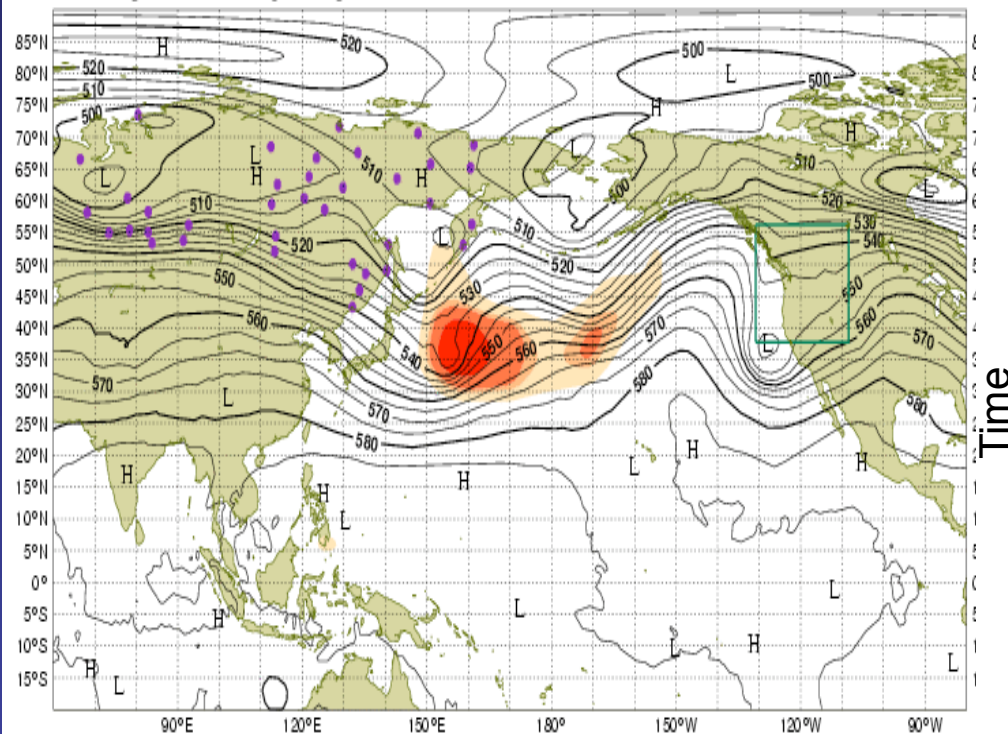
Valid time: 20090206, 12UT

Shading: areas of 8, 4, 2, 1 x 10⁶ km²

Trajectory Initialised from fc 20090204, 0 +60h (Lead time)

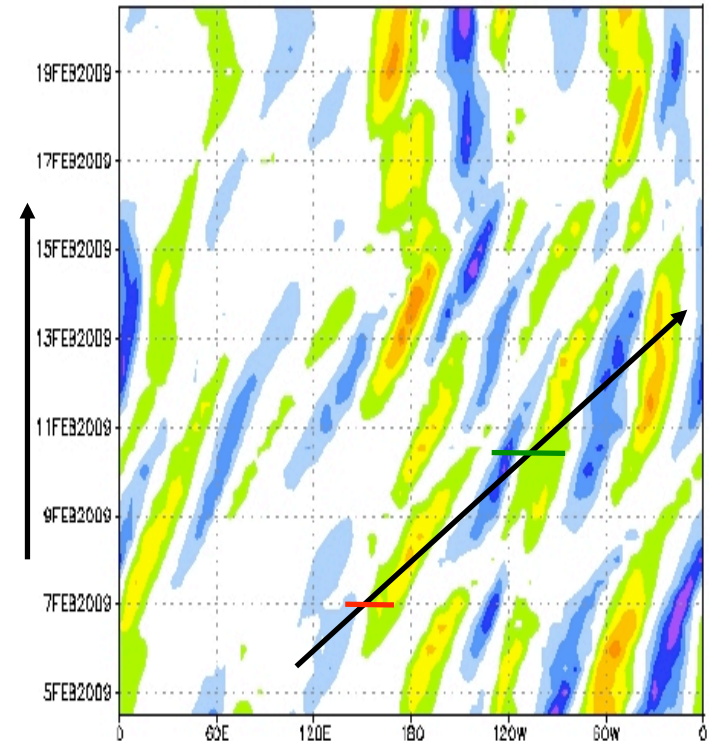
Targ. time: 20090206, 12UT / Verif. time : 20090210, 0UT (opt:84)

• targetable • operating • not available



ETKF Sensitivity (shades) and 500 hPa height (contours) at T+60h, for verification at T+144h over NW US and SW Canada (green box in figure), computed using ETKF technique based on the NCEP GFS ensemble.

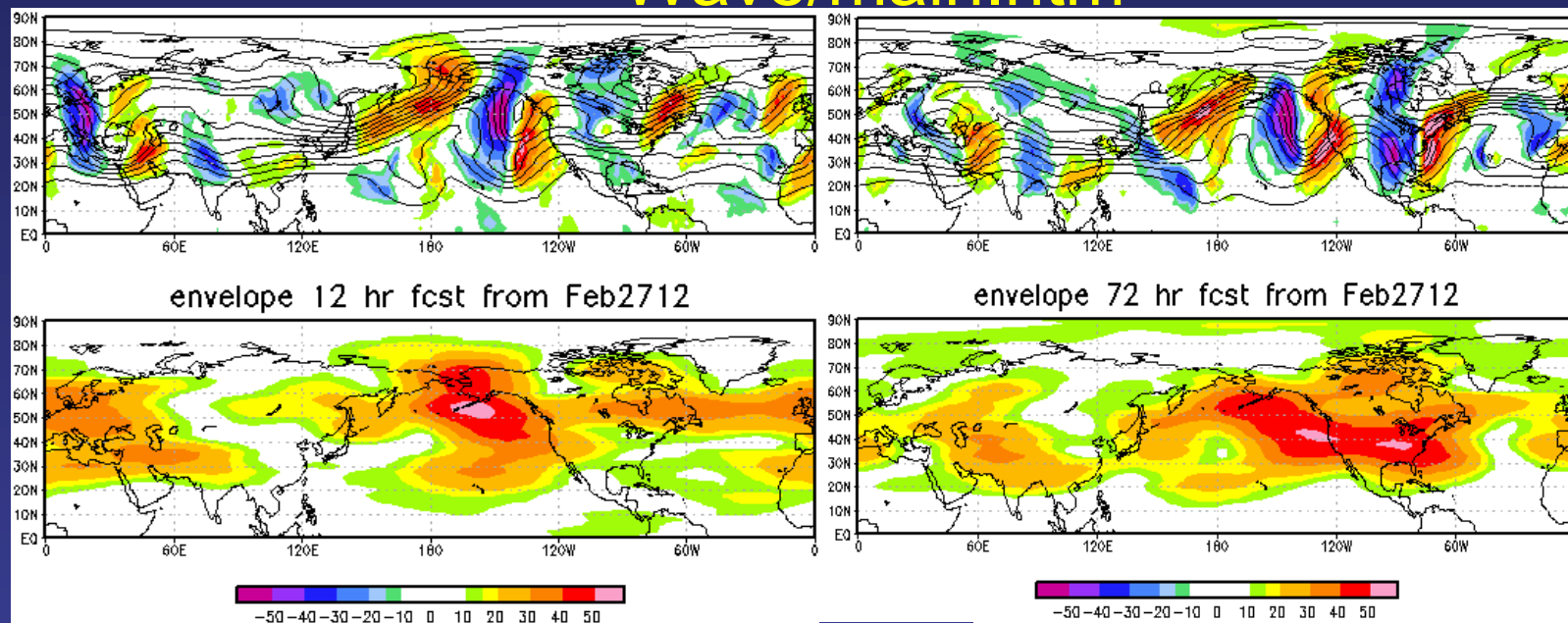
300 hPa v (30–60 N ave) fcst from 0412



Hovmoller diagram of 300 hPa meridional wind, averaged from 30–60N, as a function of time, based on the control GFS 16-day forecast.

Stony Brook Wave Packet Diagnostics for Winter TPARC

<http://xs1.somas.stonybrook.edu/~chang/personal/Wave/main.htm>



Use Complex Demodulation:

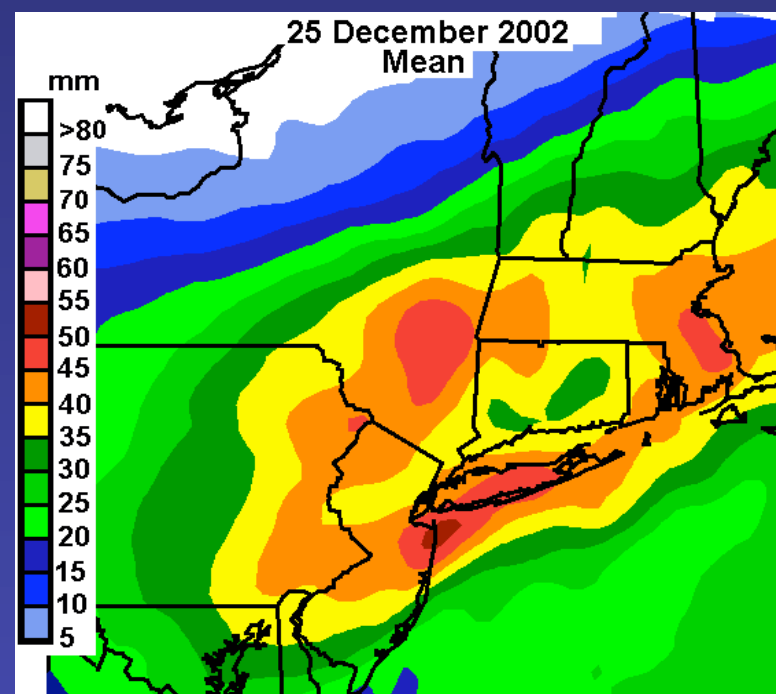
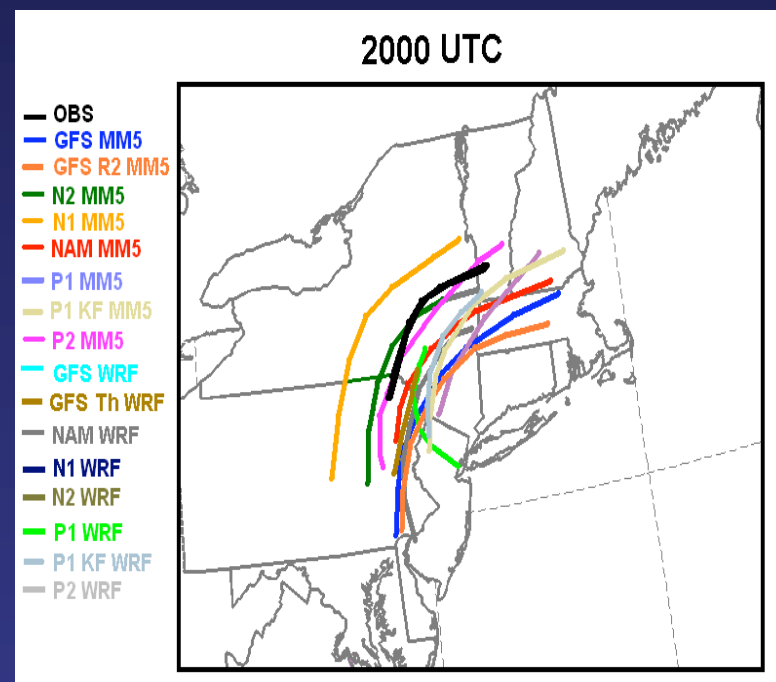
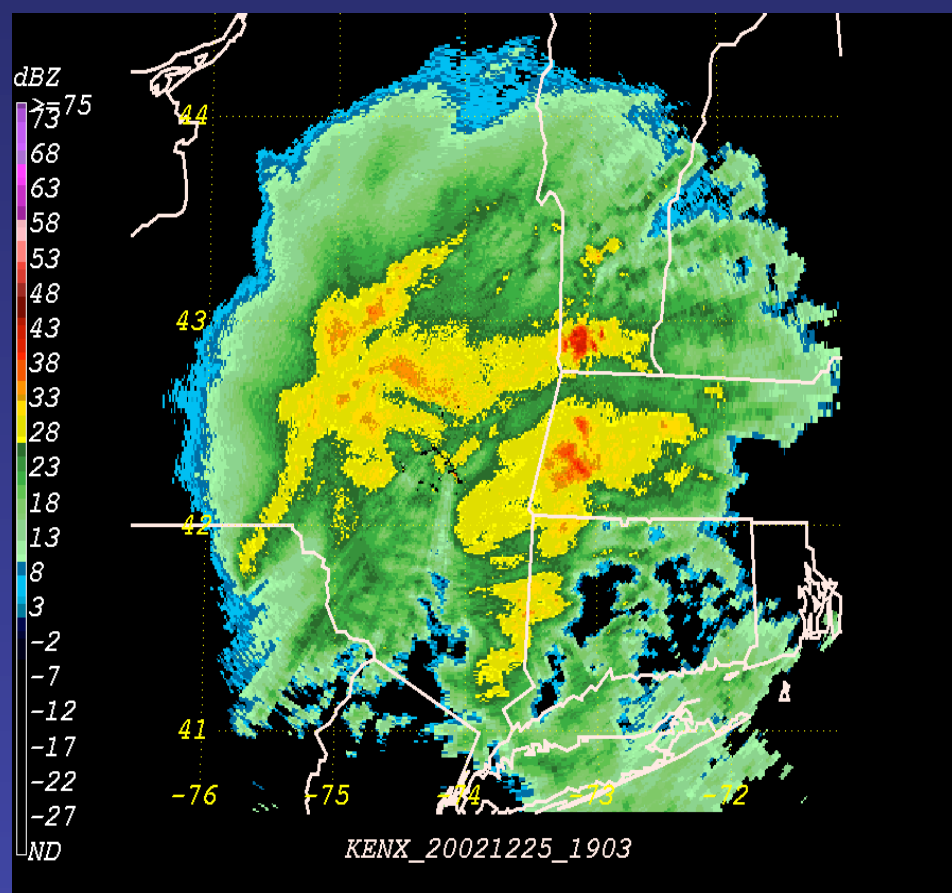
$$v' = \text{Real}(Ae^{ikx})$$

Lee, S., and I.M. Held, 1993: Baroclinic Wave Packets in Models and Observations. *J Atmos. Sci.*, 50, 1413-1428.

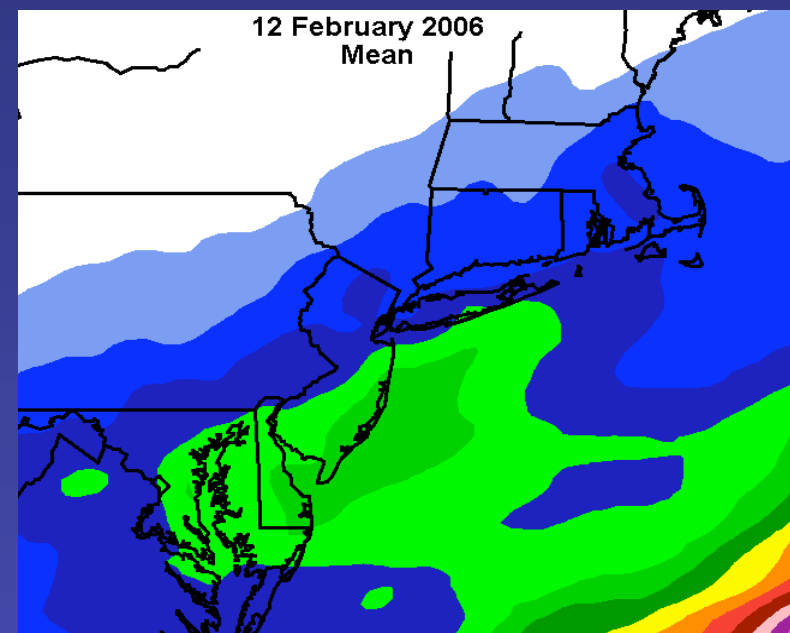
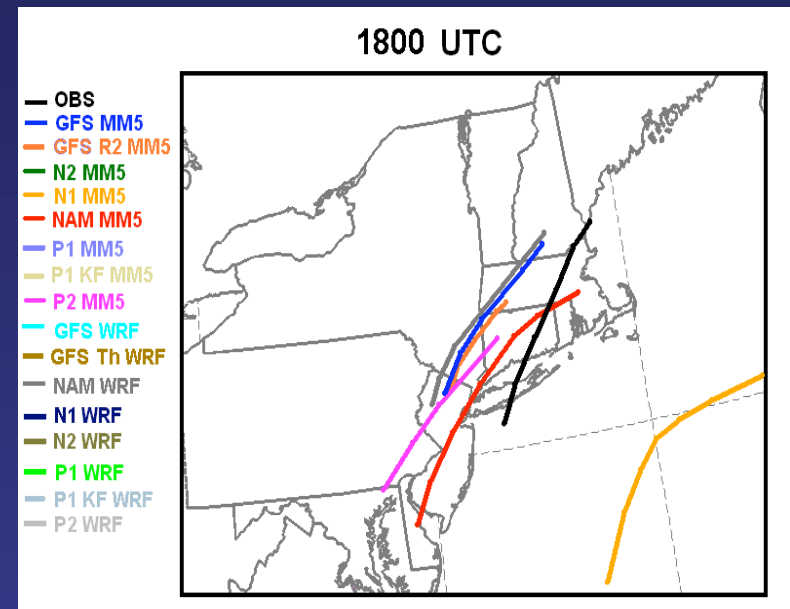
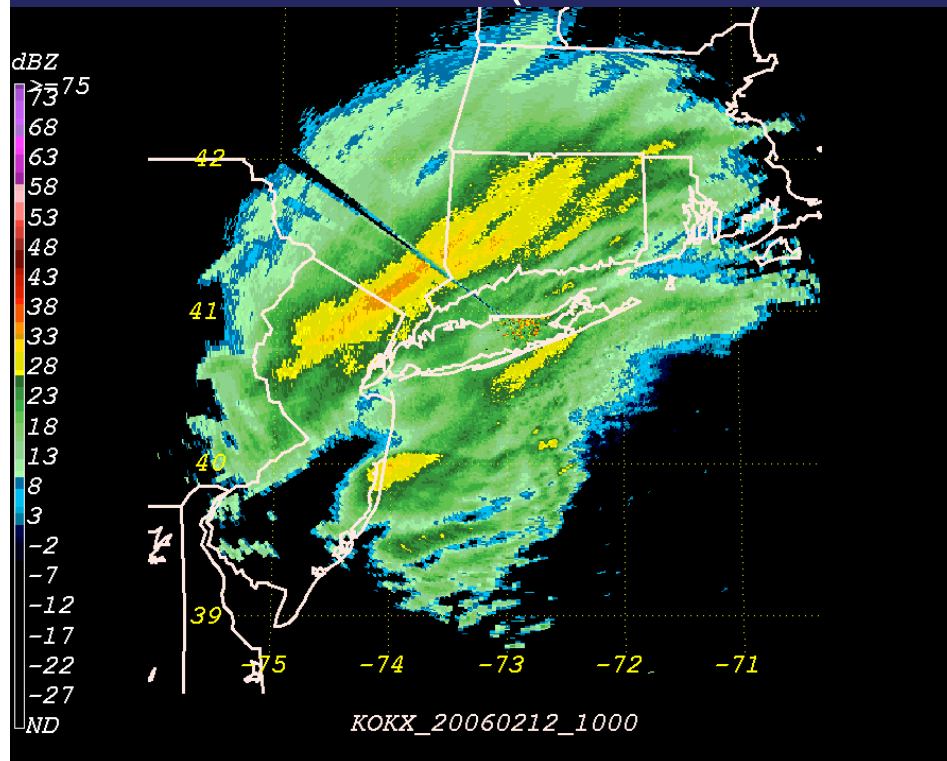
Also testing Hilbert transform technique:

Zimin, A.V., I. Szunyogh, B.R. Hung, and E. Orr: Extracting envelopes of nonzonally propagating Rossby wave packets. *Mon. Wea. Rev.*, **134**, 1329-1333.

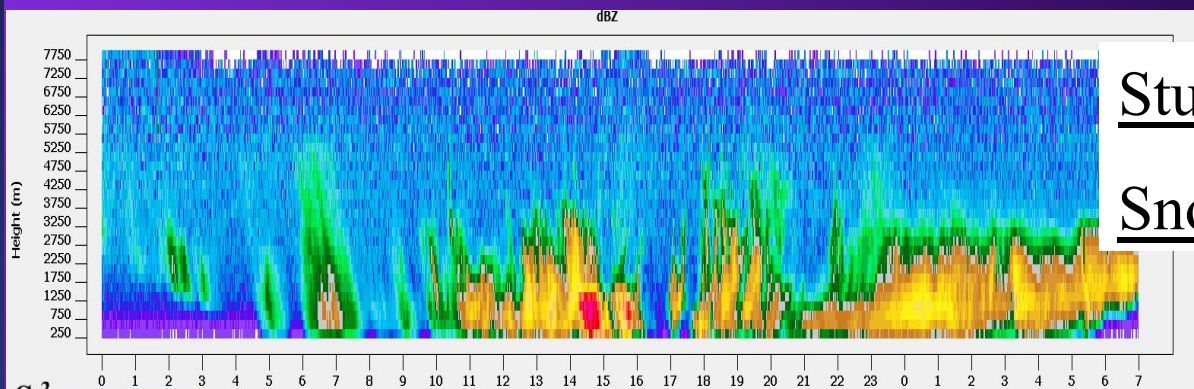
25 Dec 2002 Ensemble of 12-km MM5, WRF, NCEP SREF (15/16 produced band)



18-21h Ensemble: 12 February 2006 Event (LESS PREDICTABLE – WHY???)



Using ensemble sensitivity analysis from a ENKF system (Torn and Hakim 2008), one can identify where small changes to the initial conditions can have a significant impact on the subsequent forecast in the banding region. Forecasters can monitor observations in these sensitive regions.



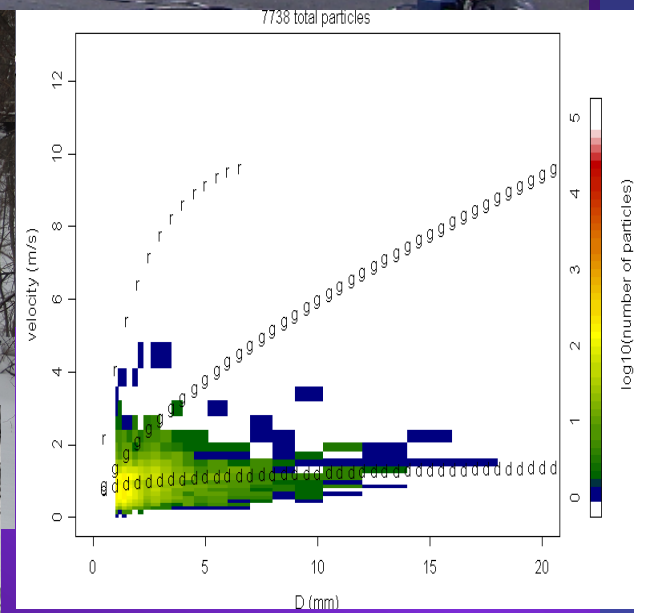
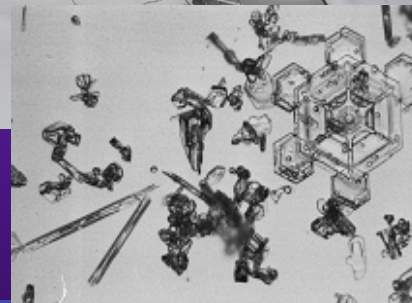
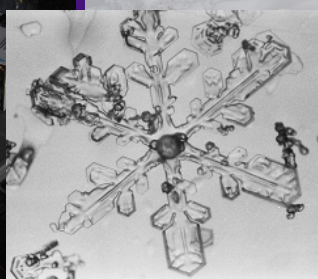
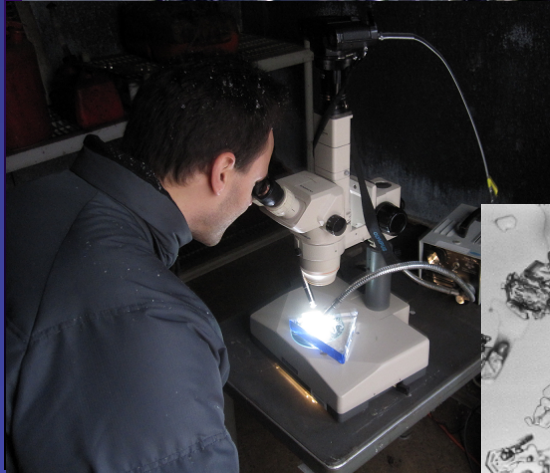
Student Field Efforts:

Snowbands on Long Island

snow/rain
particle imager

MRR vertical radar

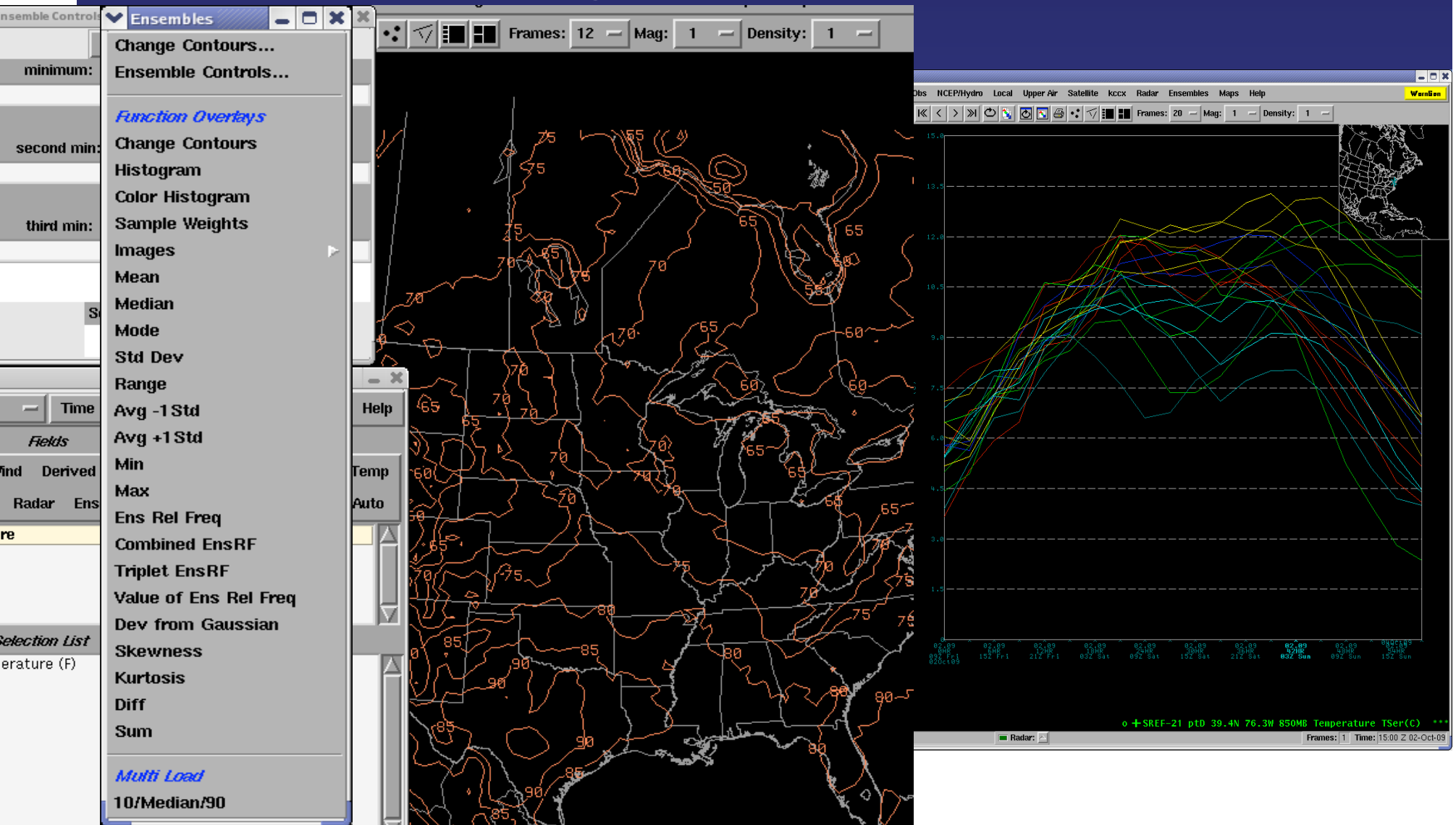
Precip gauge



Getting Ensemble Data and Stats into the Forecast Office

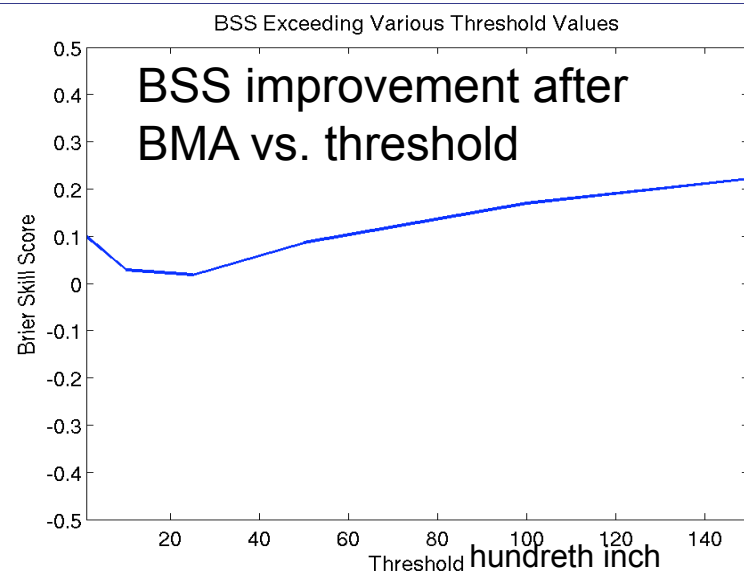
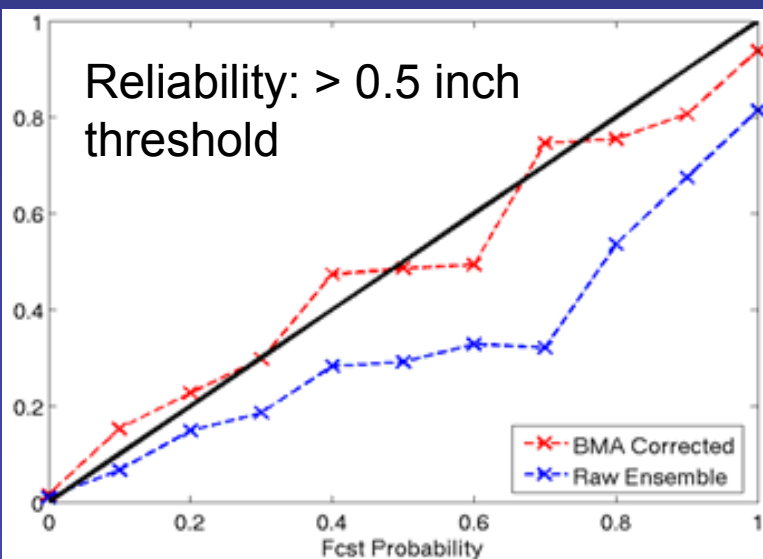
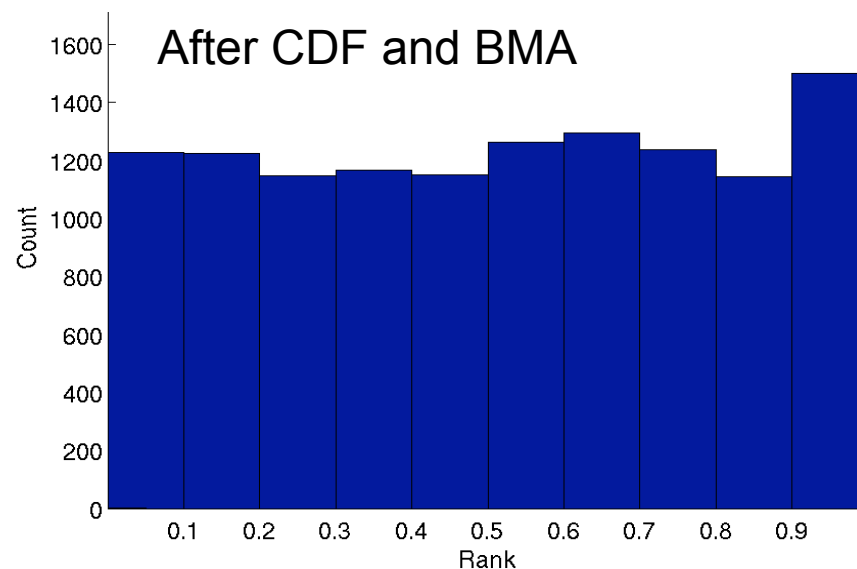
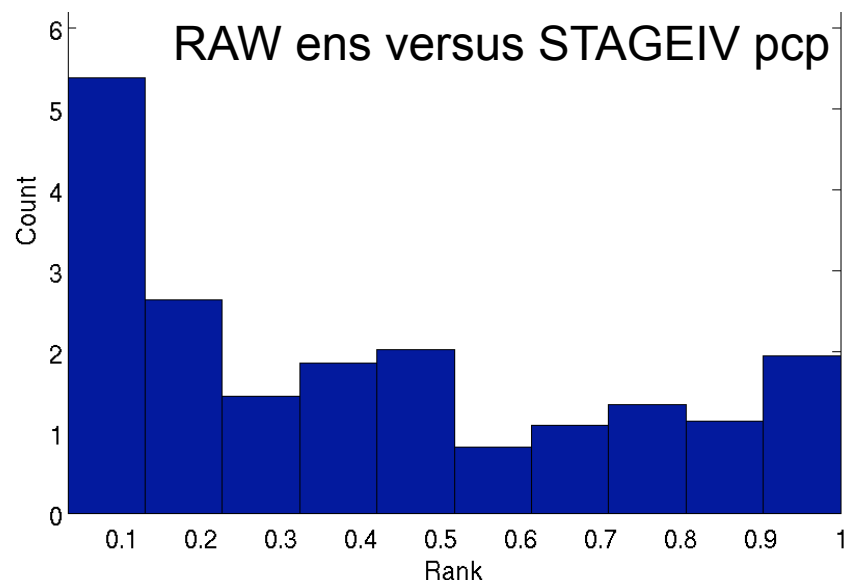
Advanced Linux Prototype System (ALPS)

<http://www-sdd.fsl.noaa.gov/~ramer/alps/ensembles/ensembles.html>



Ensemble Post-processing (Ex: 18-42h pcp NE US > 0.5")

Use cumulative distribution function (CDF) method (Hamill and Whitaker 2006) and Bayesian Model Avg on 12-km MM5,WRF, NCEP SREF



Early Objectives (Summer 2010)

- Start up CSTAR Email List Serve.
- Develop CSTAR Web Page.
- Wave Packets –Forecaster Training
- Ensemble Sensi Analysis -- Forecaster Training
- Automated Wave Packet Tracking/Verification
- Implement ALPS and share ideas how to use...
- Identify Case Studies from this past winter (DC Blizzard 3-4 Feb, NYC blizzard 19-20 Dec)